

# Sport supplement use predicts doping attitudes and likelihood via sport supplement beliefs

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1    **Sport Supplement Use Predicts Doping Attitudes and Likelihood via Sport Supplement Beliefs**

2

3    **Running title:** Sport supplements, beliefs and doping

4

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## Abstract

15 The aim of this study was to examine: (a) whether sport supplement use is related to doping  
16 and (b) whether sport supplement beliefs mediated this relationship. In Study 1, athletes ( $N$   
17 = 598), completed measures of sport supplement use, sport supplement beliefs, and doping  
18 attitudes. In Study 2, athletes ( $N$  = 475) completed measures of sport supplement use, sport  
19 supplement beliefs, and doping likelihood. In both studies, sport supplement use predicted  
20 doping outcomes indirectly via sport supplement beliefs. Our findings provide novel  
21 evidence to suggest that sport supplement users, who strongly believe that sport  
22 supplements are effective, are more likely to dope. For anti-doping organisations wishing to  
23 prevent doping, targeting an athlete's beliefs about sport supplements may improve the  
24 effectiveness of anti-doping prevention programmes.

25 **Key words:** drug, gateway hypothesis, Incremental Model of Doping Behaviour, nutrition,  
26 performance enhancement

27

## Introduction

28 According to the World Anti-Doping Agency (WADA), doping represents an athlete or  
29 athlete-support personnel (e.g. coach, physiotherapist, doctor) committing an anti-doping  
30 rule violation. Ten violations exist, including: presence of a banned substance in sample; use  
31 or attempted use of a banned substance or method; evading, refusing, or failing to submit a  
32 sample; whereabouts failure; tampering with doping control; possession of a banned  
33 substance or method; trafficking a banned substance or method; administering banned  
34 substances or methods; complicity; and prohibited association (WADC, 2015). The most  
35 widely recognised anti-doping rule violation is an athlete's use of a banned performance  
36 enhancing substance or method.

37 Factors associated with doping have received increased attention in the past decade (see  
38 Backhouse, Whitaker, Patterson, Erickson, & McKenna, 2016). Research that identifies such  
39 factors is important, as it helps anti-doping organisations and researchers design more  
40 effective anti-doping prevention programmes. A large number of factors have been  
41 proposed to explain doping in sport. It has been suggested that the use of non-banned sport  
42 supplements (e.g., caffeine, creatine and sodium bicarbonate) may increase the likelihood of  
43 an athlete doping (Backhouse, Whitaker, & Petroczi, 2013; Boardley, Grix, & Harkin, 2015).  
44 However, little research has investigated what accounts for any such relationship. Recent  
45 data highlight the potential importance of sport supplement beliefs influencing future  
46 doping (Hurst, Foad, Coleman, & Beedie, 2017b). The main rationale for this suggestion is  
47 that sport supplement use may lead athletes to develop beliefs about their effectiveness,  
48 which in turn, may lead to the development of beliefs about doping substances and  
49 influence future doping behaviour. We therefore aimed to extend understanding in the area  
50 by 1) investigating whether a relationship exists between sport supplement use and doping,  
51 and 2) whether sport supplement beliefs mediates any association.

52 *Sport Supplement Use and Doping*

53 Sport supplements are widely used by athletes of all ages and abilities, with the aim of  
54 enhancing performance, promoting recovery, and correcting or preventing nutrient  
55 deficiencies (Maughan et al., 2018). Prevalence of supplement use is between 40-70%, with  
56 estimates varying by gender, age, sport type, time of the season, and type of supplement  
57 used (Knapik et al., 2016). Whilst use of sport supplement is generally widespread, their use  
58 involves risk because supplements can be contaminated with banned substances (Geyer et  
59 al., 2004; Geyer et al., 2008). Geyer et al. (2008) analysed 634 sport supplements in 13  
60 countries and reported that 15% of sport supplements were contaminated with anabolic  
61 steroids and testosterone. Further, Cohen, Bloszies, Yee, and Gerona (2016) reported that of  
62 21 supplements sampled, 52.4% contained stimulants. Thus, for athletes using sport  
63 supplements, the possibility of failing a drug test through inadvertent means is high.

64 Cross-contamination of a sport supplement occurs as a result of insufficient surveillance and  
65 quality control by the sport supplement industry (Geyer et al., 2004). Many supplements by-  
66 pass the most rudimentary pharmaceutical safeguards and banned substances can often be  
67 added to the supplement accidentally or deliberately. Given that the World Anti-Doping  
68 Agency (WADA) enforces a “strict liability” under Articles 2.1 and 2.2 of the Code (WADC,  
69 2015; p. 141) an athlete can be banned from sport for up to 4 years after using a sport  
70 supplement without having to demonstrate “intent, negligence or knowing Use on the  
71 Athlete’s part”.

72 Researchers have suggested that use of sport supplements may over time increase the  
73 likelihood of athletes doping (e.g., Backhouse et al., 2013; Hurst et al., 2017b; Petróczi,  
74 2013). Two theoretical frameworks underpinning the sport supplement-doping association  
75 are the *gateway hypothesis* (Kandel, 1975) and the *incremental model of doping behaviour*  
76 (IMDB; Petróczi, 2013). Both propose that doping evolves as part of a routine application of  
77 the use of banned performance-enhancing substances and methods.

78 The gateway hypothesis (Kandel, 1975) posited that the use of softer drugs (e.g., alcohol,  
79 marijuana), often precedes the use of harder drugs (e.g., cocaine, heroin). In sport,  
80 researchers have suggested that the use of sport supplements may similarly facilitate use of  
81 banned substances (Backhouse et al., 2013; Hildebrandt, Harty, & Langenbucher, 2012;  
82 Hurst et al., 2017b). It is argued that supplement use could have an impact on athletes'  
83 tendency to feel comfortable with taking a substance to improve performance and lead to  
84 the use of banned substances. Thus, the continued use of sport supplements could precede  
85 and increase the likely consumption of banned substances.

86 The incremental model of doping behaviour (Petróczi, 2013) proposes a link between  
87 supplement use and doping use based on their common intended outcome of performance  
88 enhancement. The model posits that doping is a motivated, goal-directed behaviour, and  
89 prolonged involvement in performance enhancement methods can lead to doping. From  
90 this perspective, the IMDB can be seen as describing a behavioural translation, in which  
91 doping is the eventual outcome of systematic efforts aimed to maximise athletic ability  
92 through performance-enhancement methods. In short, the continued use of performance  
93 enhancement methods and the search for additional and better performance enhancing  
94 methods, could ultimately lead an athlete to dope.

95 Several studies have confirmed a positive association between sport supplement use and  
96 doping (e.g., Backhouse et al., 2013; Boardley et al., 2015; Hildebrandt et al., 2012), thereby  
97 providing support for both the gateway hypothesis and the IMDB. Qualitative studies have  
98 revealed that some athletes dope to improve performance and overcome performance  
99 plateaus while taking sport supplements (Boardley et al., 2015). Cross-sectional research has  
100 reported that supplement users are three and half times more likely to dope (Backhouse et  
101 al., 2013). In a meta-analysis, Ntoumanis, Ng, Barkoukis, and Backhouse (2014) reported that  
102 use of sport supplements was one of the strongest predictors of doping (Odds Ratio = 8.24,  
103 95% CI = 5.07 to 13.39). Although this evidence is based solely on athlete testimony, it

104 suggests that the use of sport supplements represents a risk factor for doping. Further  
105 research is needed to better elucidate the nature of the sport supplement-doping  
106 relationship.

107 It has been suggested that sport supplement users may express more favourable beliefs  
108 about their effectiveness compared to non-users (Backhouse et al., 2013; Hurst et al.,  
109 2017b). In this context, beliefs refer to perceptions of an association between behaviour  
110 (e.g., sport supplement use) and outcome (e.g., improvement in performance). Zelli, Mallia,  
111 and Lucidi (2010) reported that beliefs accounted for nearly 50% of the variance of  
112 adolescents' doping intentions. Moreover, Bloodworth, Petroczi, Bailey, Pearce, and  
113 McNamee (2012) suggested that athletes who believed that sport supplementation was a  
114 necessity for optimal sports performance were more likely to dope. Further, Hurst et al.  
115 (2017b) showed a positive association between athletes' sport supplement use and beliefs  
116 about their effectiveness. When considered alongside the main tenets of the gateway  
117 hypothesis and IMDB, this evidence suggests that the use of sport supplements may put  
118 athletes at greater risk of doping via the development of more positive beliefs about their  
119 effectiveness. However, there is relative dearth of research that has investigated sport  
120 supplement beliefs and how these may explain the sport supplement use-doping  
121 relationship. If users of sport supplements have a positive belief about the effectiveness of  
122 sport supplements, it is reasonable to suggest that these beliefs may influence future doping  
123 behaviour. The current study was designed to address this gap in our understanding of this  
124 relationship and investigate if sport supplement beliefs mediate any association between  
125 supplement use and doping.

#### 126 *Doping Attitudes and Likelihood*

127 Typically, research on substance use frames the behaviour as one of decision-making and  
128 the explicit processes involved (Hauw & McNamee, 2015). Accordingly, several researchers

129 have used the Theory of Reasoned Action (Ajzen & Fishbein, 1975) and Theory of Planned  
130 Behaviour (Ajzen, 1985) to examine athletes' attitudes and likelihood of doping (e.g.,  
131 Backhouse et al., 2013; Chan et al., 2015; Elbe & Brand, 2016). Attitudes are an evaluation of  
132 an object of thought (Bohner & Dickel, 2011) and can be anything that a person may have in  
133 mind, ranging from people, groups, ideas and objects. They are stable entities stored in  
134 memory and represent evaluative judgements that are constructed in the situation based on  
135 current accessible information (Schwarz, 2007). Researchers interested in doping attitudes  
136 are therefore aiming to understand athletes' judgements about banned substances. A large  
137 body of literature has reported that attitudes are associated with doping use (Backhouse et  
138 al., 2013; Whitaker, Long, Petróczi, & Backhouse, 2014) and doping likelihood (Chan et al.,  
139 2015; Lazuras, Barkoukis, Mallia, Lucidi, & Brand, 2017), and that users of sports  
140 supplements show more favourable attitudes towards doping than non-users (Backhouse et  
141 al., 2013; Lazuras et al., 2017).

142 The Theory of Reasoned Action also suggests that attitudes are influenced by beliefs (Ajzen  
143 & Fishbein, 1975). For example, an athlete who holds strong positive beliefs about the  
144 effectiveness of anabolic steroids is expected to have positive attitudes towards them. In  
145 turn, this influences the athlete's intention to use anabolic steroids, which ultimately  
146 influences their likelihood of using them. There is accumulating evidence to support this  
147 model of doping. Petróczi (2007) reported that stronger beliefs about doping were  
148 associated with more favourable doping attitudes. Chan et al. (2015) showed that beliefs  
149 about the advantages of using banned substances positively predicted doping attitudes and  
150 intention to dope. Other studies have shown that athletes who use sport supplements  
151 express more positive beliefs about these types of substances than non-users (Backhouse et  
152 al., 2013; Dascombe, Karunaratna, Cartoon, Fergie, & Goodman, 2010). Research examining  
153 beliefs about banned and non-banned substance use is limited, but there is sufficient  
154 evidence to suggest that they can influence doping attitudes and likelihood.



## 155 *The Present Research*

156 In sum, research assessed doping attitudes and doping likelihood in order to better  
157 understand doping behaviour. In a meta-analysis of the predictors of doping, Ntoumanis et  
158 al. (2014) reported that the use of sport supplements was one of the strongest. However, no  
159 study has investigated what may mediate the relationship between sport supplement use  
160 and doping. We conducted two studies to examine whether sport supplement beliefs  
161 mediate any relationships between sport supplement use and doping attitudes/likelihood<sup>1</sup>.  
162 In Study 1, we examined the relationships between sport supplement use, beliefs and  
163 doping attitudes, and tested two hypotheses. First, we hypothesised sport supplement use  
164 would be positively associated with doping attitudes. Second, we hypothesised that this  
165 relationship would be mediated by sport supplement beliefs. In an extension to Study 1, in  
166 Study 2, we examined the relationships between sport supplement use, sport supplement  
167 beliefs, and doping likelihood. We hypothesised that sport supplement use would be  
168 positively associated with doping likelihood and that this association would be mediated by  
169 sport supplement beliefs.

## 170 **Study 1**

### 171 **Method**

#### 172 *Participants*

173 Competitive male ( $n = 417$ ) and female ( $n = 191$ ) athletes volunteered to participate in the  
174 study (mean + SD; age =  $21.2 \pm 4.5$  years, years competing =  $10.8 \pm 5.9$ , hours per week  
175 training =  $6.0 \pm 3.7$ ). Athletes had competed at club (26.3%), county (33.3%), regional

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<sup>1</sup> We use the term doping to refer to doping attitudes and doping likelihood, when we collectively refer to these two variables.

176 (24.1%) and national level (16.3%). Athletes participated in individual (31.9%) and team  
177 sports (69.1%).

## 178 *Measures*

### 179 *Sport Supplement Use*

180 Athletes were asked to indicate whether they use sports supplements. Responses were  
181 scored as 0 (no) and 1 (yes).

### 182 *Sport Supplement Beliefs*

183 We measured sport supplement beliefs using the Sports Supplements Beliefs Scale ((SSBS;  
184 Hurst et al., 2017b). This unidimensional instrument designed to assess athletes' beliefs  
185 about the effectiveness of sports supplements was developed by Hurst et al. (2017b), who  
186 provided evidence supporting the factorial validity of SSBS scores through exploratory and  
187 confirmatory factor analyses. The SSBS includes six-statements related to beliefs about sport  
188 supplements (e.g. "sport supplements are necessary for me to be competitive"). Athletes  
189 indicated their level of agreement to each statement using a Likert-type scale, anchored by 1  
190 (*strongly disagree*) and 6 (*strongly agree*). The mean of the six statements was computed as  
191 a measure of athletes' belief about the effectiveness of sport supplements, with higher  
192 scores indicating a more positive belief in their effectiveness. Cronbach alpha values were  
193 very good in this study ( $\alpha = .91$ ).

### 194 *Doping Attitudes*

195 We measured doping attitudes with a shortened 5-item version of the Performance  
196 Enhancement Attitude Scale (Petróczi, 2006). This version has been reported to have better  
197 model fit than the original 17-item scale (Nicholls, Madigan, & Levy, 2017). Athletes  
198 responded to statements that represented their general attitudes towards doping (e.g.,  
199 "doping is necessary to be competitive") on a six-point Likert-type scale, ranging from 1

200 (*strongly disagree*) to 6 (*strongly agree*). The mean of all statements was calculated, with  
201 higher scores indicating more positive attitudes towards doping. Cronbach alpha scores have  
202 been reported to range from .71 to .91 (Petróczi & Aidman, 2009). In the current sample  
203 internal consistency was very good ( $\alpha = .90$ ).

#### 204 *Procedure*

205 After obtaining ethical approval from the institutional research ethics committee, athletes  
206 were recruited in person from sport clubs. Stakeholders of sport clubs (e.g., coaches,  
207 managers and secretaries) were first contacted via telephone and informed about the study  
208 purposes. After gaining permission to conduct the study from club stakeholders, athletes  
209 were recruited in person at the club's training facility. They were informed about the  
210 purpose of the study, that participation was voluntary, and that honesty in their responses  
211 was vital. Athletes did not disclose any personal information (e.g., names, date of births or  
212 contact details) and were told that all data would be kept anonymous and the information  
213 they provided would be used only for research purposes. After reading the study  
214 information sheet and providing informed consent, athletes completed the measures  
215 described above and returned the questionnaire in a sealed envelope.

#### 216 *Data Analysis*

217 Preliminary data analysis revealed that 10 athletes did not complete the PEAS or SSBS scale.  
218 Their data were deleted leaving a final sample size of 598 for further analyses. Eleven  
219 athletes (1.9%) had missing data and Little's Missing Completely at Random test (MCAR;  
220 Little, 1988) indicated that data were missing completely at random ( $\chi^2 = 17.562$ ,  $df = 27$ ,  $p >$   
221  $.916$ ). Missing values were replaced using a multiple imputation model that generated five  
222 data sets with maximum number of parameters set at 100. The average value of the missing  
223 data sets was used for subsequent analysis.

224 We used the PROCESS 2.16 (Hayes, 2013) SPSS macro (model 4) to test direct and indirect  
225 (via beliefs) effects of sport supplement use on doping attitudes. Direct effects are the  
226 effects of the predictor on the outcome variable that occur separately to the mediator,  
227 while indirect effects are the effects of the predictor on the outcome variable via the  
228 mediator. Bootstrapping was set at 10,000 samples to control for Type I error (Hayes, 2009;  
229 Preacher & Hayes, 2004) and bias-corrected 95% confidence intervals were calculated for all  
230 effects. When the confidence interval for indirect effects does not contain zero, this is  
231 indicative of mediation. The Completely Standardised Indirect Effect (CSIE) has been  
232 reported as the effect size metric and interpreted as 0.01 = small effect, 0.09 = medium  
233 effect and 0.25 = large effect (Preacher & Kelley, 2011). The level of statistical significance  
234 was set at  $p \leq .05$ .

## 235 **Results**

### 236 *Descriptive Statistics and Zero-Order Correlations*

237 Mean scores indicated that around half of athletes used sport supplements (51%) and  
238 overall the sample was characterised by low doping attitudes (mean  $\pm$  SD =  $2.09 \pm 0.82$ ;  
239 median = 2.00) and moderate beliefs about the effectiveness of sport supplements (mean  $\pm$   
240 SD =  $3.01 \pm 1.12$ ; median = 3.17). Zero-order correlations provided support for our first  
241 hypothesis, that is sport supplement use was positively associated with attitudes towards  
242 doping ( $r = .11, p = .005$ ). Also, positive relationships were found between sport supplement  
243 use and beliefs about sport supplements ( $r = .51, p < .001$ ) and between sport supplement  
244 beliefs and doping attitudes ( $r = .26, p < .001$ ).

### 245 *Mediation Analysis*

246 We hypothesized that sport supplement beliefs would mediate the relationship between  
247 sport supplement use and doping. This hypothesis was also supported as sport supplement  
248 use had an indirect effect on doping attitudes via sport supplement beliefs ( $b = 0.22$ , 95% CI

249 = 0.14 to 0.31, CSIE = 0.13, 95% CI = 0.09 to 0.19). In contrast, sport supplement use did not  
250 have a direct effect on doping attitudes ( $b = 0.03$ , 95% CI =  $-0.17$  to  $0.27$ ). Overall the model  
251 accounted for 26% of the variance in doping attitudes ( $F_{(2, 593)} = 207.62$ ,  $p < .001$ ,  $r = .51$ ).  
252 Results are presented in Figure 1.

## 253 Discussion

254 Researchers have supported the notion that an athlete's use of sport supplements is related  
255 to doping attitudes (e.g., Backhouse et al., 2013; Ntoumanis et al., 2014). However, to date,  
256 no study has attempted to understand the process through which sport supplement use  
257 may lead to doping. One potential explanation is that over time athletes develop beliefs  
258 about supplements. To move beyond simple description of the supplement use-doping  
259 relationship and extend understanding in this area, we investigated whether this  
260 relationship was mediated by sport supplement beliefs. The support provided for this  
261 mediational pathway suggests that use of sport supplements may lead athletes to develop  
262 beliefs about their effectiveness, possibly due to perceived improvements in performance.  
263 These beliefs, in turn, may lead to the development of favourable attitudes toward doping  
264 with possible implications for doping behaviour. The absence of a direct effect of sport  
265 supplement use on doping attitudes underscores the importance of beliefs as a mechanism  
266 that could explain the link between supplement use and doping attitudes.

## 267 Study 2

268 The results of Study 1 provided evidence consistent with the hypothesis that the relationship  
269 between sport supplement use and doping attitudes is mediated by sport supplement  
270 beliefs. However, the measure we used to assess doping attitudes has been criticised by  
271 some researchers for its poor predictive validity in relationship to doping behaviour (Nicholls  
272 et al., 2017). Specifically, the five-item version of the PEAS represents a mix of governmental  
273 (e.g., "legalising performance enhancement would be beneficial for sport"), moral ("doping

274 is not cheating”) and functional (“doping is necessary to be competitive”) statements.  
275 Therefore, when using this scale it is not possible to determine which of these sub-  
276 components of doping attitudes is/are most important.

277 As an alternative, researchers have advocated the use of hypothetical scenarios to assess  
278 doping intentions (e.g., Huybers & Mazanov, 2012; Kavussanu & Ring, 2017; Ring &  
279 Kavussanu, 2018). Athletes are presented with a hypothetical situation that they may  
280 encounter in their career and are asked to indicate how likely they would be to use a banned  
281 substance, if they were in that situation. Doping likelihood is reported to be one of the  
282 strongest predictors of doping behaviour (Ntoumanis et al., 2014) and has previously been  
283 shown to identify athletes at risk of doping (Kavussanu & Ring, 2017; Ring & Hurst, 2019;  
284 Ring, Kavussanu, Simms, & Mazanov, 2018). Therefore, in Study 2, we extended the results  
285 of Study 1 by aiming to 1) examine the relationship between athletes’ use of sport  
286 supplements and doping likelihood, and 2) determine whether beliefs about the  
287 effectiveness of supplements mediate this relationship.

## 288 **Method**

### 289 *Participants*

290 Four-hundred and eighty-one competitive athletes volunteered to participate in the study  
291 (age =  $20.3 \pm 2.2$  years; years competing =  $5.9 \pm 4.2$ , hours per week training =  $6.3 \pm 4.4$ ).  
292 The sample comprised mostly males (69.5%), who competed in team (88.8%) and individual  
293 (11.2%) sports. The highest ever standard at which the athletes had competed at in their  
294 sport was club (27.6%), county (45.7%), regional (6.7%), and national level (20.0%).

### 295 *Measures*

#### 296 *Sport Supplement Use and Beliefs*

297 These variables were assessed using the same measures described in Study 1.

298     *Doping Likelihood*

299     In line with previous research (Huybers & Mazanov, 2012; Kavussanu & Ring, 2017; Ring &  
300     Kavussanu, 2018), we asked athletes to indicate how likely they are to dope during a  
301     hypothetical scenario. This scenario focused on the benefits of using a banned substance to  
302     help improve performance for a future competition and is presented below:

303             *It's the week before the most important competitive game/event of your season.*  
304             *Lately, your performance has been below your best. You don't feel you have the*  
305             *necessary fitness for this competition, and you're concerned about how you'll*  
306             *perform. You mention this to a teammate, who tells you that he/she uses a new*  
307             *substance that has enhanced his/her fitness and performance. The substance is*  
308             *banned for use in sport, but there's no chance that you will be caught.*

309     After reading the scenario, athletes were asked to rate how likely they were to use the  
310     banned substance on a Likert-type scale ranging from 1 (*strongly disagree*) to 7 (*strongly*  
311     *agree*).

312     *Procedure*

313     After gaining ethical approval from the university research ethics committee, athletes were  
314     recruited from sports clubs. Recruitment strategy and instructions were identical to those in  
315     study 1, and athletes provided informed consent and completed the measures previously  
316     described.

317     *Data Analysis*

318     Preliminary examination of the data revealed that six athletes did not complete the SSBS  
319     scale. These were deleted, leaving a final sample size of 475. Two athletes (0.42%) had  
320     missing data and Little's MCAR test revealed data were missing completely at random ( $\chi^2 =$   
321     5.142,  $df = 10$ ,  $p > .882$ ). Missing values were replaced using a multiple imputation model

322 that generated five data sets with maximum number of parameters set at 100. The average  
323 value of the missing data sets was used in subsequent analysis.

324 Similar to Study 1, we used the PROCESS 2.16 (Hayes, 2013) SPSS macro (model 4) to test  
325 direct and indirect effects of sport supplement use on beliefs and doping likelihood.  
326 Bootstrapping was set at 10,000 samples and bias-corrected 95% confidence intervals were  
327 calculated for all effects. The CSIE was reported as the effect size metric and the level of  
328 statistical significance accepted was at  $p \leq .05$ .

## 329 **Results**

### 330 *Descriptive Statistics and Zero-Order Correlations*

331 Descriptive statistics indicated that on average, over two thirds of athletes used  
332 supplements (69%) and reported relatively moderate beliefs in their effectiveness (mean  $\pm$   
333 SD =  $3.12 \pm 1.41$ ; median = 3.67). Athletes also reported relatively low doping likelihood  
334 scores (mean  $\pm$  SD =  $2.27 \pm 1.53$ ; median = 2.00). Supporting our first hypothesis, zero-order  
335 correlations showed the use of sport supplements was positively associated with likelihood  
336 of doping ( $r = .15$ ,  $p = .002$ ). Further, positive relationships were identified between sport  
337 supplement use and sport supplement beliefs ( $r = .46$ ,  $p < .001$ ), and that stronger sport  
338 supplement beliefs and likelihood of doping ( $r = .22$ ,  $p < .001$ ).

### 339 *Mediation Analysis*

340 Our second hypothesis posited that the relationship between supplement use and doping  
341 likelihood would be mediated by sport supplement beliefs. As can be seen in Figure 2, sport  
342 supplement use was not directly related to doping likelihood ( $b = 0.17$ , 95% CI = -0.15 to  
343 0.50), but was indirectly related to doping likelihood via sport supplement beliefs ( $b = 0.31$ ,  
344 95% CI = 0.15 to 0.49, CSIE = 0.09, 95% CI = 0.05 to 0.15). Overall the model accounted for  
345 21% of the variance in doping likelihood ( $F_{(2, 473)} = 143.52$ ,  $p < .001$ ,  $r = .46$ ).



## 346 Discussion

347 Similar to Study 1, in Study 2, we found that sport supplement use indirectly predicted  
348 doping likelihood via sport supplement beliefs. This finding suggests that users of sport  
349 supplements may be more likely to dope because supplement use may lead one to develop  
350 beliefs about their effectiveness. In turn, these beliefs may influence doping likelihood.

## 351 General Discussion

352 It has been proposed that the use of sport supplements can lead an athlete to dope  
353 (Backhouse et al., 2013; Hurst et al., 2017b; Petróczi, 2013). Building on research conducted  
354 on the role of sport supplement use and doping (Backhouse et al., 2013), we examined the  
355 associations between athletes' use of sport supplements and both doping attitudes and  
356 doping likelihood, and whether beliefs about the effectiveness of supplements mediated any  
357 of these associations.

358 In support of our hypotheses, we found that sport supplement use was positively associated  
359 with both doping attitudes (Study 1) and doping likelihood (Study 2). These results are in line  
360 with existing cross-sectional research (Backhouse et al., 2013; Hildebrandt et al., 2012),  
361 which has reported a positive relationship between sport supplement use and doping. While  
362 sport supplements may help athletes meet nutritional targets, train harder, and stay healthy  
363 and injury-free (Maughan et al., 2018), their continued consumption may also lead to a  
364 greater willingness to engage in doping (i.e., via the gateway hypothesis or IMDB). If athletes  
365 perceive sport supplements as beneficial for performance, they may subsequently be more  
366 likely to consider doping. These findings provide some support for the gateway hypothesis  
367 and IMDB, namely, that the use of performance enhancing methods (e.g., sport  
368 supplements) could increase the likelihood of an athlete doping.

369 To our knowledge, this is the first study to examine the mediating role of sport supplement  
370 beliefs in the sport supplement use-doping relationship. Our findings are consistent with the

371 hypothesis that sport supplement beliefs mediate the relationship between sport  
372 supplement use and both doping attitudes and likelihood. This suggests that athletes who  
373 use sport supplements may develop beliefs about their effectiveness over time and as a  
374 result be more likely to dope. This may happen because athletes believe that doping can  
375 improve performance to the same, or to a greater extent to that of supplements. In other  
376 words, the perceived beneficial effects of sport supplements may augment the belief that  
377 they are effective, which in turn may lead to doping. Given the IMDB, which posits that the  
378 continued use of non-banned performance enhancing methods can lead to doping (Petróczi,  
379 2013), the more an athlete believes in the effectiveness of these types of methods, the  
380 more likely they are to dope. Overall, our results underline the potentially important role of  
381 sport supplement beliefs in doping.

### 382 *Practical Implications*

383 Our findings have practical implications for organisations and researchers aiming to prevent  
384 doping in sport. They show that sport supplement use is indirectly related to doping  
385 attitudes and likelihood via beliefs about the effectiveness of sport supplements. Thus, anti-  
386 doping prevention programmes need to focus on reducing the belief about the effectiveness  
387 of sport supplements. This could be achieved by downplaying their effectiveness during  
388 nutritional and anti-doping interventions. There is a body of evidence suggesting that a large  
389 proportion of the effectiveness of sport supplements is the result of a *placebo effect* (Beedie  
390 et al., 2018; Hurst, Foad, Coleman, & Beedie, 2017a). Informing athletes about the placebo  
391 effect could help them to make more informed choices about the use of sport supplements  
392 and banned substances, which, in turn, may modify their beliefs about their effectiveness.

393 Alternatively, a more indirect way to modify beliefs could be for practitioners to promote an  
394 environment that fosters behaviours away from the use of sport supplements. For example,  
395 providing athletes with a “food-first approach” could provide athletes with functional

alternatives to sport supplementation (Whitaker & Backhouse, 2017). This may indirectly modify an athlete's behaviour in relationship to supplements. For example, instead of an athlete adopting non-natural forms of nutrition, such as powders and pills, that athlete may adopt more natural means of nutrition, and have a reduced belief in the effectiveness of sport supplements. It is reasonable to suggest that based on the results of this and other studies (Backhouse et al., 2013; Hurst et al., 2017b), as well as the gateway hypothesis and the IMBD, a reduction in the use of sport supplements might change an athlete's belief in their effectiveness, and subsequently the chance of that athlete doping.

#### *Limitations and Future Research Directions*

In this multi-study research programme, we have reported some novel findings. However, these need to be interpreted in light of the following limitations. First, both studies are cross-sectional, and, therefore, a causal link between supplement use and doping outcomes cannot be asserted. It could be argued that beliefs about supplements influence supplement use which in turn influences doping. In regards to the latter, we were unable to analyse this relationship as supplement use was measured on a dichotomous scale (i.e. 0 = no, 1 = yes). Future research should examine whether supplement use acts a mediator between supplement beliefs and doping. Similarly, researchers should also investigate how athletes develop beliefs about banned and non-banned substances and whether they are related to future substance use. This could help determine how athletes learn and interpret information about performance enhancing substances, which could be used to facilitate the development of anti-doping educational interventions. Second, the effect sizes between sport supplement use and doping were small ( $r = .11$  and  $.15$ , for doping attitudes and likelihood, respectively). This suggests that any potential causal relationship between the use of sport supplements and doping could be influenced by other factors that may be more influential in leading athletes to dope. Third, and like other research in this area (Kavussanu & Ring, 2017; Ring et al., 2018), participants had relatively low doping attitudes and

422 likelihood scores. It is unknown whether the results from this study are similar for athletes  
423 with higher scores on these variables. Future research is therefore needed that examines  
424 the mediating role of sport supplements and the supplement use-doping relationship in an  
425 athletic sample with higher doping scores.

## 426 **Conclusion**

427 In conclusion, the results from our research demonstrate that sport supplement use is  
428 related to both doping attitudes and doping likelihood. That is, athletes using sport  
429 supplements are more likely to report a more favourable attitude to doping and indicate a  
430 greater likelihood of doping. Moreover, we provide novel evidence to suggest that sport  
431 supplement users, who have a strong belief in the effectiveness of the supplements, may be  
432 more likely to dope, and these beliefs may explain the relationship between sport  
433 supplement use and doping. For anti-doping organisations and researchers aiming to  
434 prevent doping, targeting athletes' beliefs about the effectiveness of sport supplements may  
435 improve anti-doping prevention programmes. Research investigating the effects of belief-  
436 based interventions on sport supplement use in sport is now needed.

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### Figure Captions

**Figure 1.** The effects of supplement use on doping attitudes and the mediating role of sport supplement beliefs. *Note.* Values are the unstandardized regression coefficients. \*  $p < .01$

**Figure 2.** The effects of supplement use on doping likelihood and the mediating role of sport supplement beliefs. *Note.* Values are the unstandardized regression coefficients. \*  $p < .01$